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(54) Method of producing perforated glass

(57) A method of producing perforated glass comprises heating glass 3 to a molten state such that the molten glass flows around perforation members 6 having a cross-section corresponding to the desired perforations to be formed in the glass. The perforation members 6 may initially rest on the glass disc, the members being pushed through the disc when it reaches a molten state. Alternatively, ground or cut glass 3 may be injected into a space in which the members 6 are already provided. The member 6 may be of copper, the difference in coefficient of expansion from that of the glass facilitating easy removal thereof once the glass has cooled. In the event that the members 6 have substantially the same coefficient of expansion as that of the glass, the members 6 may be dissolved or etched away by a suitable chemical.

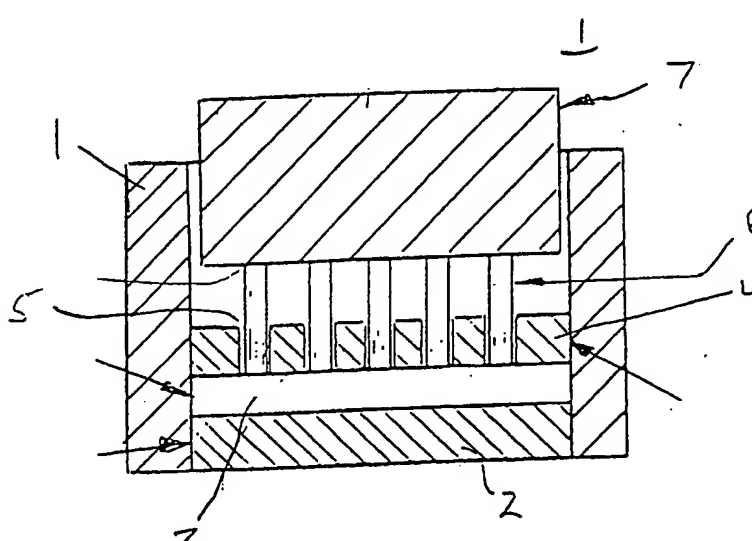

FIG1

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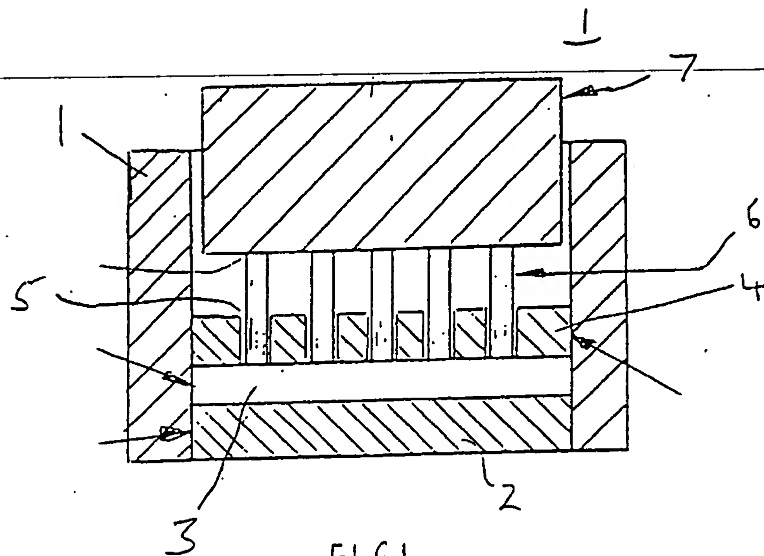

FIG1

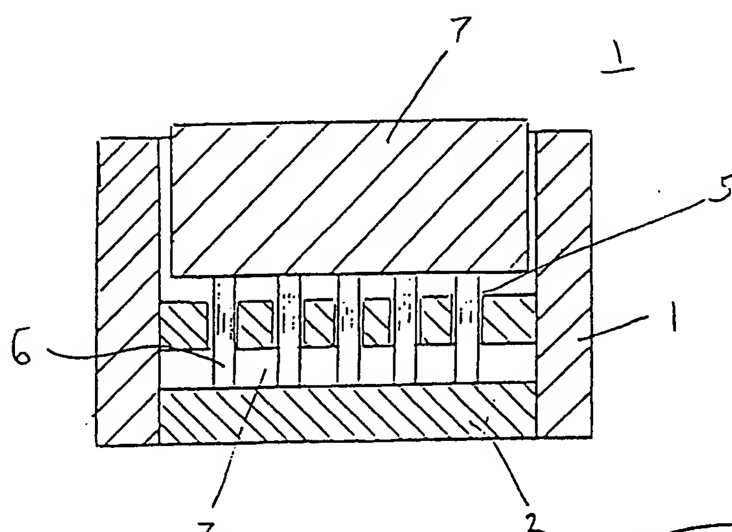

FIG2.

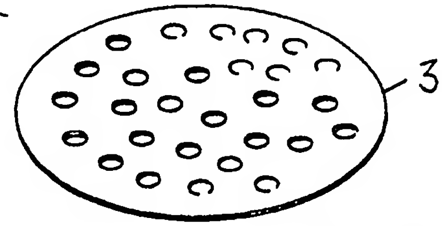

Fig3.

METHODS OF PRODUCING PERFORATED GLASS

This invention relates to methods of producing perforated glass.

There is a need in, for example, the semi-conductor industry, to produce thin glass wafers having one or more perforations. The perforations may be of the order of 1.6 mm in diameter. One possible use for such a perforated glass wafer is as a pressure sensor. In this case, the glass wafer is bonded to a silicon wafer. The silicon wafer and glass disc is sliced into about 300 sections. An electrical circuit is connected to the silicon and provides an output indicative of ambient pressure. Once calibrated, the output can be used as a measurement of pressure. The purpose of the glass is to provide a mechanical support for the silicon.

A conventional method of producing such glass wafers comprises drilling a desired number of the perforations or holes one by one into a 75 mm diameter wafer by means of a conventional rotary drill or laser cutting device. The wafer is then cut into pieces each having the required number of perforations according to its required application.

This method of producing perforated glass has the disadvantage that it is both time consuming and expensive.

It is an aim of the present invention to provide a method for producing perforated glass more quickly and cheaply.

According to the present invention, there is provided a method for producing perforated glass comprising heating the glass to a molten state such that the molten glass flows around one or more perforation member(s), cooling the glass to a solid state, and removing the perforation member(s), wherein the perforation member(s) has a cross-section corresponding to the desired perforation(s) to be formed in the glass. In one embodiment of the invention, the perforation member(s) has a coefficient of expansion which is greater than that of the glass.

The method preferably includes urging the perforation member(s) through the glass blank after the blank has reached the molten state. The perforation member(s) may be weighted so that it/they move downwardly through the glass during the molten state. A single weight may be placed upon the end(s) of the perforation member(s) remote from the end(s) contacting the glass blank.

In this embodiment of the invention, the method comprises placing the unperforated glass blank between a pair of plates prior to the heating step, one of which plates comprises holes corresponding to those desired to be formed in the glass blank. The perforation member(s) is/are guided by the holes of the plate.

In an alternative embodiment, glass in the form of glass powder, beads, cut glass tubes, or glass cullet may be injected into a mould so as to surround the perforation member(s) prior to the heating step. Glass may be injected into the mould by other convenient means.

Once the glass has solidified, the perforation member(s) can be removed in groups of one or more at a time. In a preferred embodiment, the perforation members are cylindrically shaped rods, their leading ends having a curved profile to assist lead-in of the members into the molten glass.

In embodiments of the invention, the perforated glass can be produced within a housing in which surfaces which come into contact with the glass are coated or formed so that wetting is prevented between the surface and the glass. To achieve this, the surfaces may be formed of or coated with carbon.

The perforation members or rods may be formed of copper which has a higher coefficient of expansion than that of glass. The consequence of this is that during cooling, the copper rods contract to a greater extent than the perforations formed by the rods. The rods are therefore easier to move from the solidified glass after penetration during the molten state.

The number of perforation members, their relative positions, and their cross-sections can be varied according to requirements.

After the perforations are formed, the glass blank may be lapped or ground and polished to leave a glass blank of the desired thickness if required.

In an alternative method embodying the invention, removal of the perforation member(s) is achieved by etching or dissolving the members in a suitable chemical which does not attack the glass disc. In such embodiments, the coefficient of expansion of the members may be about the same as that of the glass.

Methods embodying the present invention have the advantage that they enable perforated glass discs or blanks to be produced easily and cheaply.

The invention will now be described by way of example, with reference to the accompanying drawing in which:

Figures 1 and 2 illustrate a jig for performing a method of producing perforated glass according to one embodiment of the present invention; and

Figure 3 is a perspective view of a perforated glass disk produced according to a method embodying the invention.

Figure 1 illustrates a jig 1 comprising a housing consisting of a cylindrical wall 1 of carbon and a flat carbon base 2. A disk shaped glass blank 3, having a diameter corresponding to that of the base 2, is positioned so that one face of the disc 3 contacts the base 2.

The glass blank 3 is sandwiched between the base 2 and a perforated upper disc 4 which is also formed of carbon. Use of carbon for surfaces of the jig which contact the glass prevents wetting, ie prevents the glass adhering to the jig when molten. The upper perforated disc 4 comprises a plurality of holes 5 which each guide a respective copper rod 6. The ends of the copper rods 6 remote from the ends contacting the glass disc 3 are in

contact with a steel weight 7 which acts down upon the glass via the rods 6.

~~The assembly illustrated in Figure 1 is heated to a~~ temperature of, for example 900°C, so that the glass melts. As the glass melts and while the glass is in a molten state, the copper rods 6 are pushed into and through the glass disc under the weight of the steel block 7. The copper rods 6 are guided by the holes 5 provided in the upper disk 4.

In a preferred arrangement not shown, the leading ends of the copper rods 6 may be rounded so as to assist guiding thereof into the glass.

Figure 2 illustrates the position of the copper rods 6 after they have contacted the base 2 and fully penetrated the glass disc 3. Once the assembly has cooled, and the glass solidified, the block 7 and rods 5 can be removed. The rods may be removed individually from the holes 5 formed in the glass disc 3. The glass disc can then be removed from the jig 1 and lapped or ground and polished to the desired thickness if required.

Conceivably, all of the rods 5 may be permanently fixed to the weight 7 so that time can be saved in both the assembly and disassembly operations.

By way of example, the copper rods 5 may have a diameter of 1.6 mm. The glass disc 3 could initially have a thickness of 4 mm and be subsequently ground down to 3 mm. The weight 7 may have a mass of 500 gms.

CLAIMS

1. A method for producing perforated glass comprising heating the glass to a molten state such that the molten glass flows around one or more perforation member(s), cooling the glass to a solid state, and removing the perforation member(s), wherein the perforation member(s) has a cross-section corresponding to the desired perforation(s) to be formed in the glass.

2. A method according to Claim 1, wherein the perforation member(s) has a coefficient of expansion which is greater than that of the glass.

3. A method according to Claim 1 or Claim 2, wherein the glass is initially in the form of a glass blank and the perforation member(s) is/are urged through the glass blank after the blank has reached the molten state.

4. A method according to Claim 3, wherein the perforation member(s) are weighted so that it/they move downwardly through the glass during the molten state.

5. A method according to Claim 4, wherein a single weight or block is placed upon the end(s) of the perforation member(s) remote from the end(s) contacting the blank.

6. A method according to any one of the preceding claims, including initially placing the unperforated glass blank between a pair of plates prior to the heating step, one of which plates comprises one or more holes corresponding to those desired to be formed in the glass blank.

7. A method according to Claim 1 or Claim 2, wherein the glass is initially injected into a mould in the form of a glass powder or beads so as to surround the perforation member(s) prior to the heating step.

8. A method according to any one of the preceding claims comprising removing the perforation member(s) from the solidified glass in groups of one or more at a time.

9. A method according to any one of the preceding claims, wherein the perforation member(s) is/are removed by a chemical etching process which dissolves away the member(s).

10. A method according to Claim 10, when not dependent upon Claim 2, wherein the coefficient of expansion of the perforation member(s) is substantially the same as that of the glass.

11. A method according to any one of the preceding claims, wherein the perforation member(s) is/are in the form of cylindrically shaped rods.

12. A method according to any one of Claims 1 to 10, wherein the perforation member(s) is/are in the form of rods having a square or rectangular cross-section.

13. A method according to Claims 11 or 12, wherein the leading ends of the rods have a curved profile to assist lead-in of the rods into the molten glass.

14. A method according to any one of the preceding claims, wherein the perforation member(s) are of copper.

15. A method of producing perforated glass according to Claim 1 substantially as hereinbefore described.

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